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February 29, 1844.

SIR J. W. LUBBOCK, Bart., V.P., in the Chair.

“On the Electrolysis of Secondary Compounds.” By John Frederic Daniell, Esq., D.C.L., For. Sec. R.S., and Professor of Chemistry in King’s College, London; and W. A. Miller, M.D., Demonstrator of Chemistry in the same College.

The authors of this paper have further prosecuted the inquiry into the phenomena of electrolysis, commencing from the point to which it had been carried by Professor Daniell in his papers published in the Philosophical Transactions for 1839 and 1840. He had there shown, that in the electrolysis of neutral saline solutions, if the metal is one of those which do not decompose water at ordinary temperatures, it is precipitated in the metallic state at the platinode; but if it belong to the class of those which, at ordinary temperatures, do decompose water, then an equivalent of the oxide is liberated at the platinode, while an equivalent of hydrogen makes its escape in the gaseous form from the same electrode; the acid, in both cases, being, at the same time, liberated at the zincode, accompanied by an equivalent proportion of oxygen. On comparing these results with those of an independent voltameter included in the same circuit, it was found that a certain definite proportion of the force which resolves a single equivalent of a *simple* electrolyte into its anion and cation, produces the resolution of a full equivalent of a *complex* electrolyte into a simple metallic cation and a compound anion. When ammoniacal salts in solution were thus decomposed, ammonia, with an equivalent of hydrogen, was liberated at the platinode; while the acid, with an equivalent of oxygen, was evolved, as before, at the zincode.

Experimental evidence was thus obtained in support of two important theories; namely, the ammonium theory advanced by Berzelius; and the binary theory of salts propounded by Davy; in which latter theory, all saline compounds are regarded as being formed on the type of the salts of the hydro-acids. This binary composition of salts is, in the present paper, proved to exist, not only when the salts, previously held in solution by water, are decomposed by the voltaic current, but also when the fused anhydrous salt is electrolysed: for example, metallic silver in crystals is deposited upon the platinode, when fused nitrate of silver is included in the circuit.

On examining, by the current, the monobasic, dibasic, and tribasic phosphates, the authors found that there were three distinct modifications of the acid transferred. From the monobasic phosphates there was obtained the metaphosphoric acid; from the dibasic salts, pyrophosphoric acid; and from the tribasic salts, the ordinary phosphoric acid was set free at the zincode. The acids were transferred into weak alkaline solutions and recognised by their appropriate tests. The view entertained by Professor Graham of the composition of these salts is therefore completely confirmed.

On the other hand, the authors found, by similar experiments made with the yellow and the red prussiates of potash, that only one com-

pound of cyanogen and iron, or ferrocyanogen as it exists in the yellow salt, is evolved at the zincode; and they not only converted the yellow into the red salt by electrolytic action, but, conversely, reproduced the yellow from the red.

In pursuing their researches on double salts, a new order of facts was brought to light, which clearly proved that although the two ions of the electrolyte are always *evolved* in equivalent proportions, yet that they are not *transferred* in equivalent proportions to the respective electrodes; that some bases, such as copper, zinc, iron and alumina, do not travel at all towards the platinode; that some, as magnesium, do so in small proportion only; and that others, as barium and potassium, are transferred in greater abundance; those whose oxides are most soluble appearing to travel most easily. On the other hand, the acids, whether forming soluble hydrates or not, seem all to travel towards the zincode, in proportions dependent principally on the nature of the base with which they are united.

The curious phenomena which have thus been brought to light, concur in establishing the general fact, that the disengagement of the cation and anion of an electrolyte in equivalent proportion is not always affected, as is commonly represented, by their simultaneous transfer in opposite directions to their respective electrodes, in the exact proportion of half an equivalent of each; but that it is sometimes brought about by the transfer of a whole equivalent of the anion to the zincode, whereby a whole equivalent of the cation is left uncombined at the platinode, or by the transfer of unequivalent portions of each in opposite directions, making together a whole equivalent of matter transferred either to one electrode or to the other; or, in other words, by the transfer of a quantity of matter capable of exercising one equivalent of chemical force: so that when the anion transferred to the zincode exceeds half an equivalent, the cation transferred to the platinode is, in an equal proportion, less than half an equivalent, and *vice versa*; the anion and cation set free being always in equivalent proportions. In no case, however, has there been observed the transfer of a whole equivalent of the cation to the exclusion of the anion.

These facts, the authors conceive, are irreconcilable with any of the molecular hypotheses which have been hitherto imagined to explain the phenomena of electrolysis.

March 21, 1844.

The MARQUIS OF NORTHAMPTON, President, in the Chair.

“A description of certain Belemnites, preserved, with a great proportion of their soft parts, in the Oxford clay at Christian Malford, Wilts.” By Richard Owen, Esq., F.R.S., &c., Hunterian Professor of Anatomy and Physiology in the Royal College of Surgeons.

The author describes, in the present paper, specimens of Belemnite, discovered in the Oxford-clay at Christian Malford, Wilts, and